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SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic and Combined Cycle Propulsion (5)

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STUDY ON THERMAL NONEQUILIBRIUM LASER-SUPPORTED ABSORPTION WAVE AND LASER-POWERED AIR-BREATHING PULSE DETONATION THRUSTER

Abstract

A laser-powered air-breathing pulse detonation thruster utilizes the remote laser energy and atmosphere air to boost a vehicle. To calculate the performance, one dimension (1D) laser-supported absorption wave in air was simulated by an implicit dual-time method, and laser absorption efficiencies were predicted, based on a more accurate absorption model and three temperatures thermal nonequilibrium. Sequentially, impulses for different parabolic thrusters and pulse energies were computed, considering high-temperature real gas effect. Then experiments were conducted with a ballistic pendulum apparatus. The calculations of 1D absorption wave show that as laser intensity increases, electron number density would reach the critical value, resulting in laser reflection and descent of absorption efficiency. Further calculations for thrusters imply the thrust oscillation due to air-refilling has an evident influence on total impulse received, and because of higher thrust peak and longer positive phase time, the flat top and longer configuration would significantly enhance the performance. Experimental results show that the errors of impulse calculation for two thrusters are 4.2% and 9.4% respectively, which verifies the calculation model.